NOAA FISHERIES
Southeast Fisheries Science Center

Stock Structure – Marine Mammals

SEFSC Protected Species Program Review

25-27 August 2015
Miami, Florida

Marine Mammal Stocks- MMPA Mandates

Intertwining population-level and ecosystem-level objectives

The primary objective of marine mammal management "should be to maintain the health and stability of the marine ecosystem."

- Species or stocks should remain a significant functioning element of their ecosystem
- The historic range should be preserved
- Stocks need to be maintained at their "optimum sustainable population" level (OSP)

Stock Definition

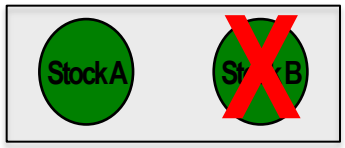
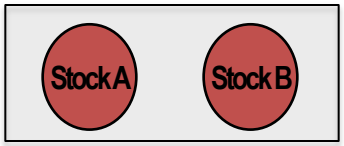
MMPA Unit of Management = "Population Stock"

A group of marine mammals of the same species or smaller taxon in a common spatial arrangement, that interbreed when mature

Functionally

- Groups that are demographically independent– where a population's growth rate is more a function of internal population processes (birth and death rates) than it is a function of external dynamic forces (immigration and emigration)
- Demographic independence: dispersal rates are less than a few percent per year
- Groups delineated by a low rate of genetic exchange
- SEFSC relies primarily on genetic data for delimiting stocks

Importance of Accurate Stock Delimitation

Identified	Reality	Result
		• Incorrect abundance estimate for estimating allowable mortality • Risk local depletion or extinction • Risk losing unique diversity and adaptation • Does not maintain range
		• Restrictive on fishery or other commercial endeavor

Importance of Accurate Stock Delimitation

Understanding stock structure provides the means to:

- Know who you are counting; accurate abundance estimates
- Know who is being impacted
  - Assess impacts of human-caused mortalities on the appropriate group
  - Protect unique gene pools
  - Protect local adaptation
  - Assess the health of the populations and quantify the risks
  - Understand trends in health parameters and disease
- Meet mandates under MMPA to maintain stock range and abundance

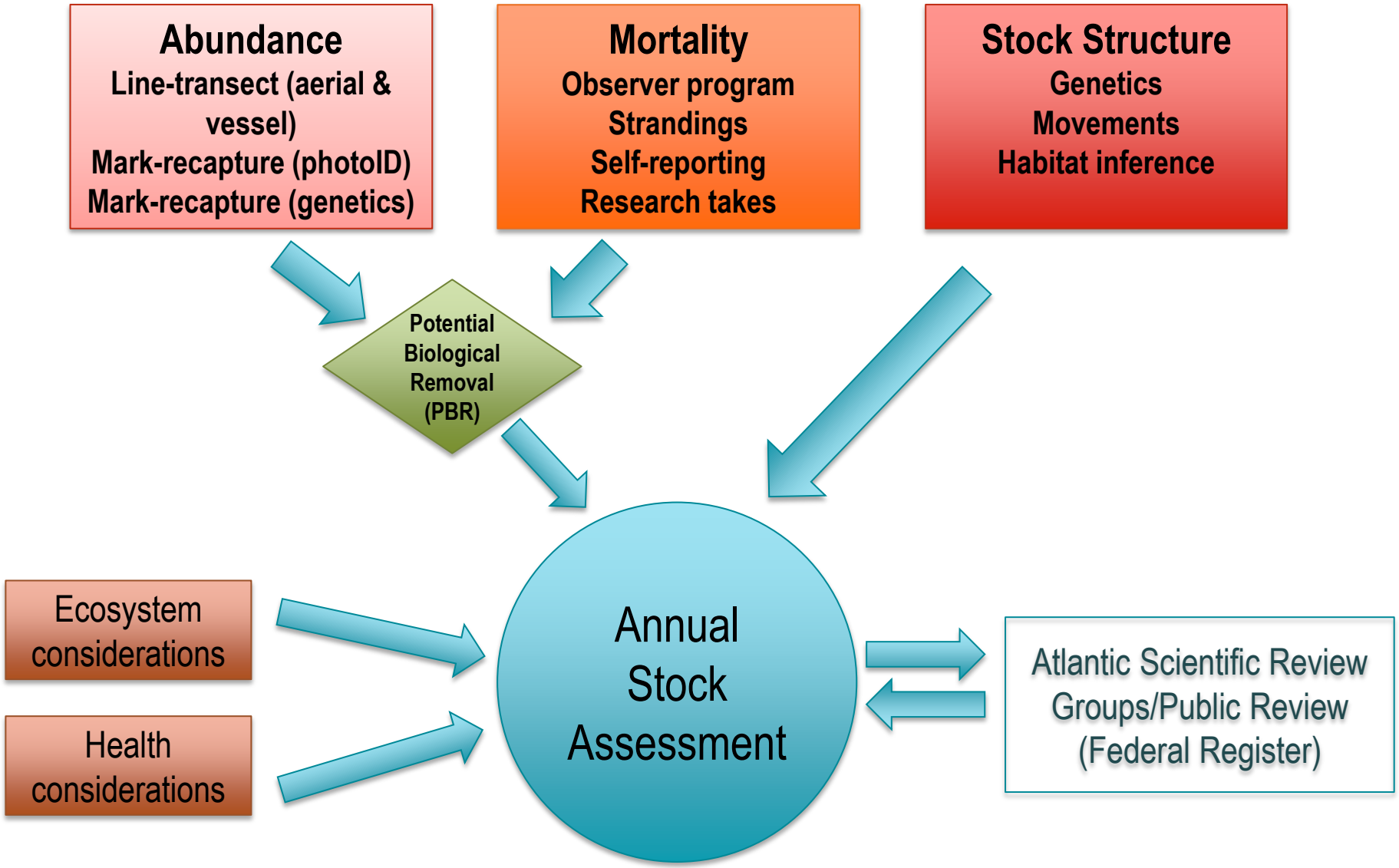
Applications of Stock Structure Delineation

- MMPA Stock Assessment Reports
- Take Reduction Plan Development
- Section 7 consultation
- Injury Assessment (Bycatch, DWH)

Striped dolphins in oiled waters. SEFSC MMPA Permit

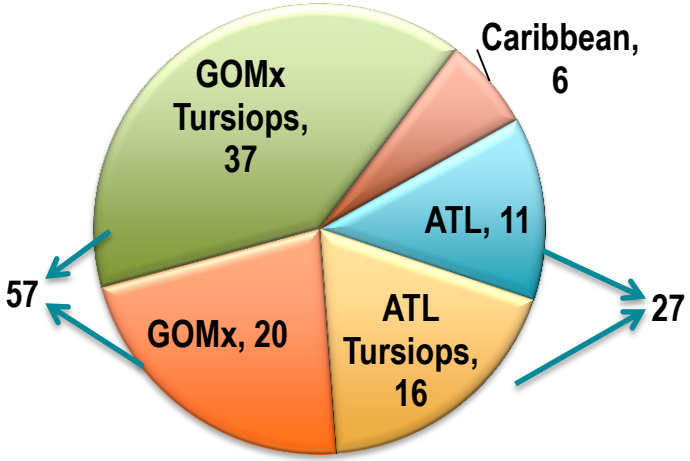
Dolphin rescue after Hurricane Rita

Marine Mammal Stock Assessments

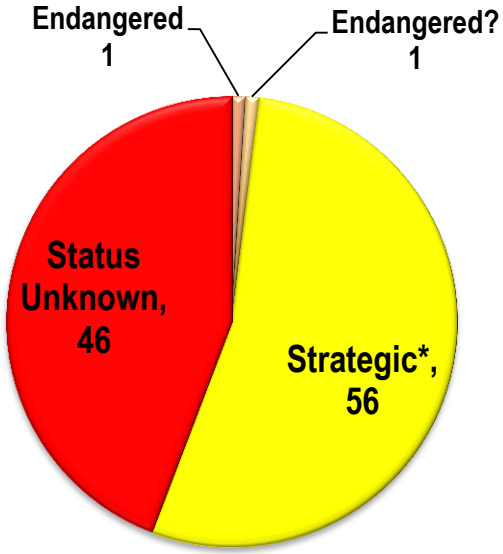


Marine Mammal Stock Structure Needs

SEFSC Responsible for 90 Marine Mammal SARs



Status under ESA and MMPA



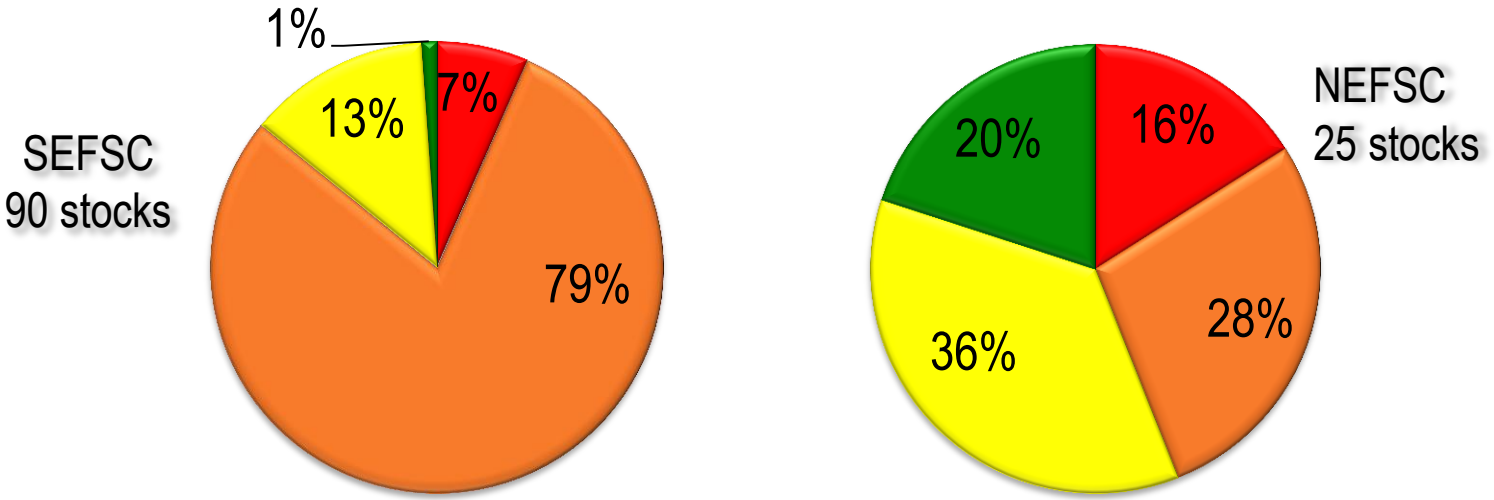
* Human-caused mortality exceeds allowable levels

Marine Mammal Stock Structure Assessment

Adequacy of Stock Structure Information

(from 2004 Stock Assessment Improvement Plan, SAIP)

- 0 - **No information** (qualitative or otherwise)
- 1 - Structure **inferred** from analyses undertaken for other purposes
- 2 - Structure inferred from an analysis **specifically aimed at investigating population differentiation**
- 3 - Structure inferred from an integrative analysis of **at least two lines of evidence**
- 4 - **Estimates of dispersal rate** that include estimates of uncertainty



SEFSC Stock Structure Research

Goal: Identify demographically independent populations

Standards for stock structure delineation

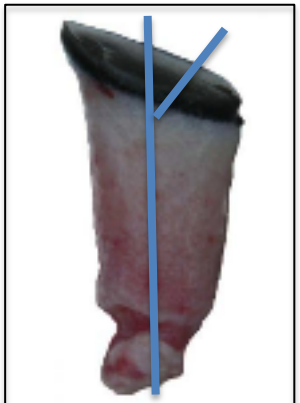
- Appropriate sample size, geographic sampling, temporal sampling
- Appropriate genetic markers and analytical tools

Methods

- Identify stock(s) to focus on – prioritize stocks
- Design field sampling – spatial and temporal sampling
- Collect and analyze data – Marine Mammal Molecular Genetics Laboratory in Lafayette, LA

SEFSC Stock Structure Research - Sampling

- Large vessel surveys - shelf and oceanic stocks
  - Opportunistic during abundance surveys
  - Some dedicated biopsy cruises
- Small boat biopsy surveys- coastal and estuarine stocks
  - Directed
  - Labor intensive
- Strandings

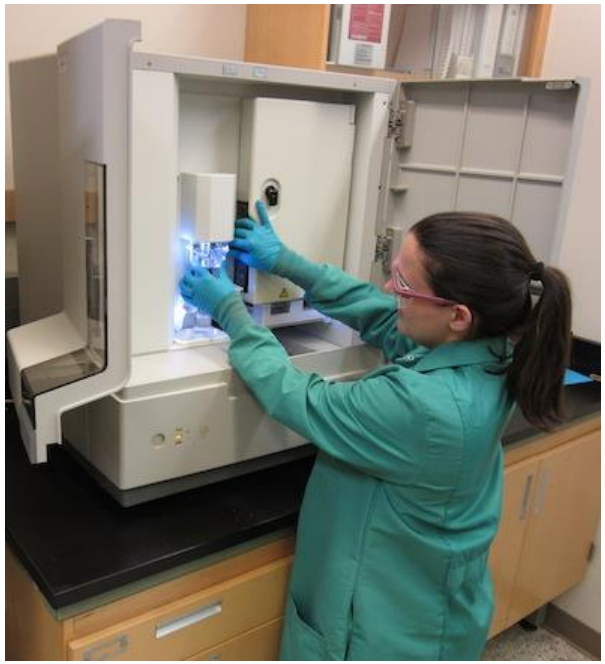


Typical biopsy sample which is subsampled for multiple analyses

SEFSC Stock Structure Research- Laboratory Work

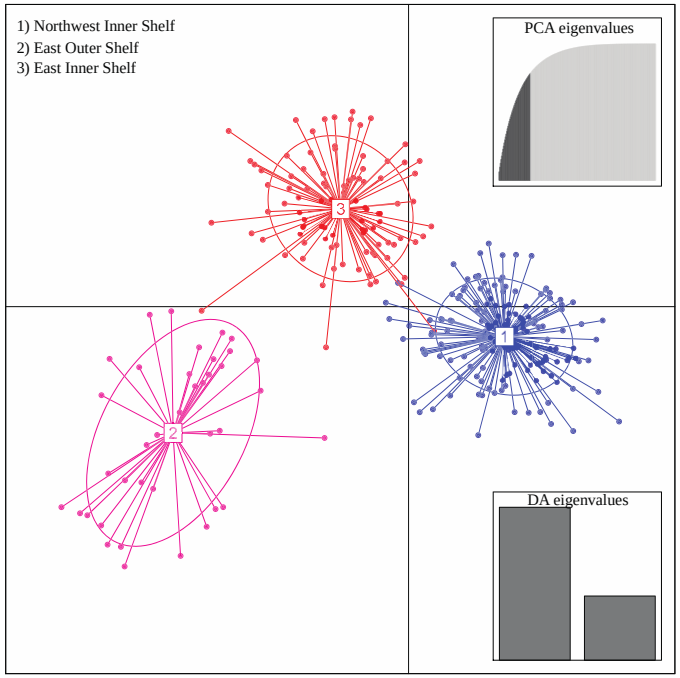
Marine Mammal Molecular Genetics Lab, Lafayette, LA

- ~1,200 square feet facility
- 2 permanent staff, 1 contract technician
- Well-equipped facility for genetic analysis of stock structure, phylogenetics, genetic species identification



SEFSC Stock Structure Research- Markers and Analyses

- **Markers**
  - mitochondrial DNA sequence data
  - 19-41 nuclear microsatellite loci
  - Single nucleotide polymorphisms (SNPs)
- **Analyses**
  - Population structure
    - F_{ST} and analogues
    - STRUCTURE (Bayesian cluster analysis)
    - Principal components analysis
    - MIGRATE (historical migration rates)
  - Phylogenetic reconstructions
    - Maximum likelihood and Bayesian methods



Differentiation among bottlenose dolphins on the shelf of the northern Gulf of Mexico

Drivers for Prioritization of Stocks for Genetic Studies

- **Management needs and priorities**
  - **Take Reduction Teams (fisheries interactions/bycatch)**
    - Pelagic Longline TRT (both pilot whale species)
    - Bottlenose dolphin TRT (Atlantic coast)
  - **Other human interactions**
    - Unusual Mortality Events
    - Catastrophic events (e.g., oil spills)
    - Unauthorized research takes
    - Illegal harassment activities
    - Degree of commercial and residential development
- **Biological characteristics**
  - Population size (e.g., small bay, sound and estuary stocks, Bryde's whales)
  - Taxonomic uncertainty (e.g., Atlantic spotted dolphins)
  - Health-related issues (e.g., *Kogia*)

Completed and ongoing studies

Take Reduction Teams (i.e., commercial fisheries bycatch)

- Harbor porpoises (NEFSC) – gillnet fisheries
- Short-beaked common dolphins (NEFSC) – gillnet and trawl
- Bottlenose dolphins on Atlantic Coast (SEFSC) – gillnet fisheries
- Pilot whales (both species, both centers) – longline and trawl fisheries

Uncertain taxonomy leading to inaccurate stock structure

- Atlantic spotted dolphins in NWAtl and GOMx (both centers)
- Bryde's whales in Gulf of Mexico (SEFSC)

Bottlenose dolphins (Large stocks and small stocks)

- Gulf of Mexico open water stocks (SEFSC)
- Gulf of Mexico Bay, Sound and Estuary stocks (SEFSC)

Atlantic Spotted Dolphin – Taxonomic uncertainty, cryptic population structure in GOMx

Problem: One stock in Atlantic with morphological differentiation

Goal:

1) Determine degree of genetic differentiation among Atlantic spotted dolphin morphotypes
2) Determine distribution of the two morphotypes in the western North Atlantic so stock structure accurately reflects the differentiation
3) Determine stock structure in ATL and GOMx

Method:

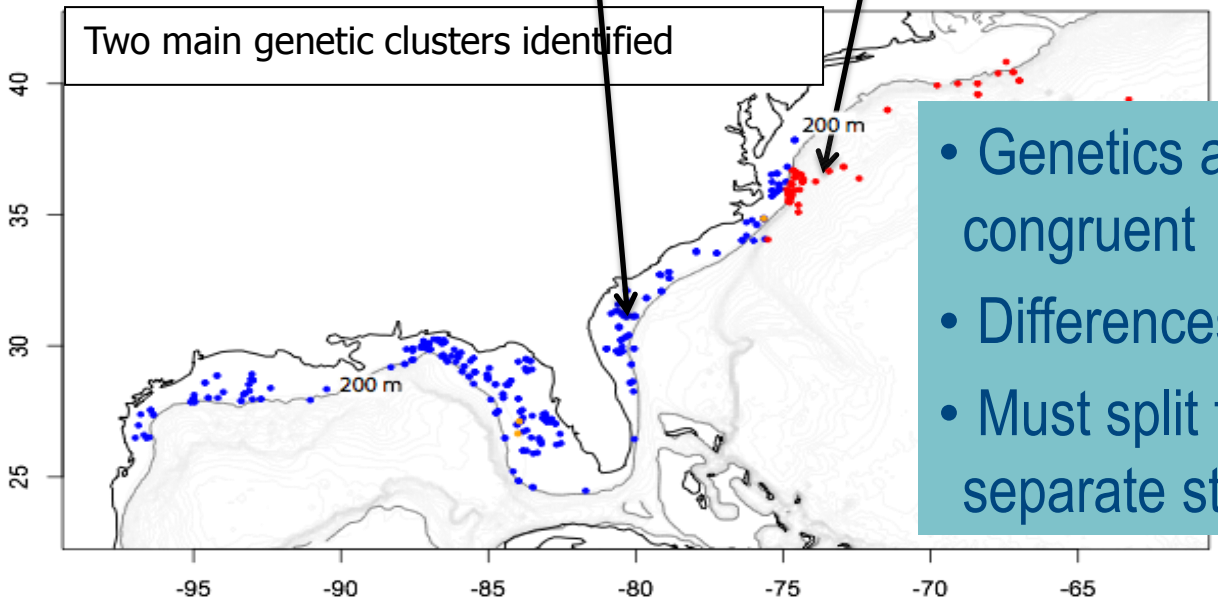
- n=397 over 11 years
- Sequenced mitochondrial control region
- Genotyped 19 microsatellite markers

Atlantic spotted dolphin SEFSC MMPA Permit

Atlantic Spotted Dolphin- Taxonomic uncertainty

Continental shelf waters
Larger body size and skull
Medium to heavy spotting (in adults)

Offshore waters and around oceanic islands Smaller body size and skull
Few spots

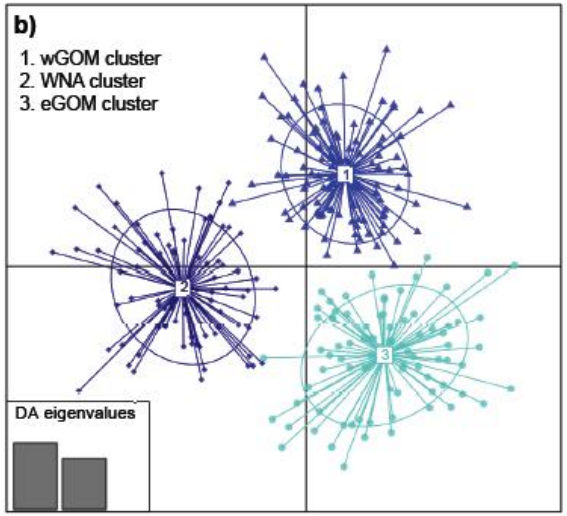


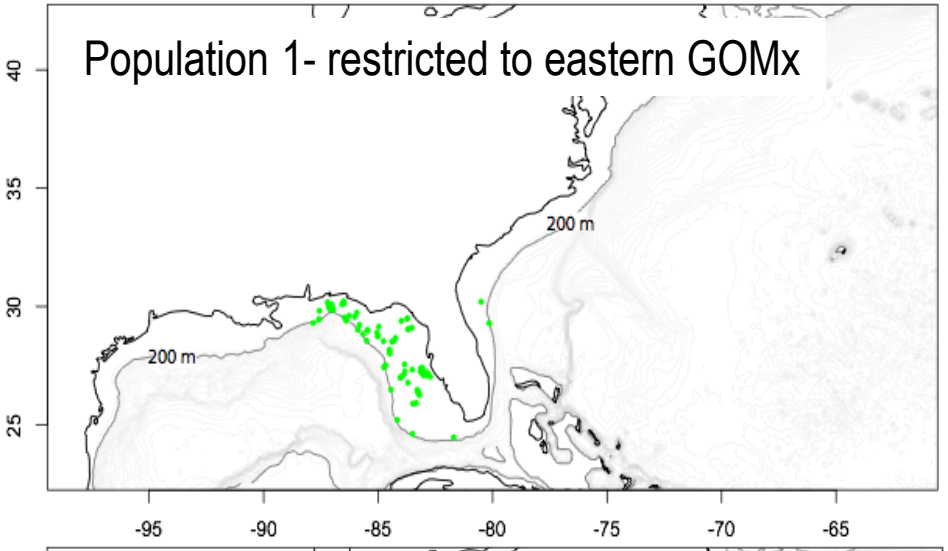
- Genetics and morphology are congruent
- Differences near sub-specific level
- Must split the Atlantic stock into two separate stocks

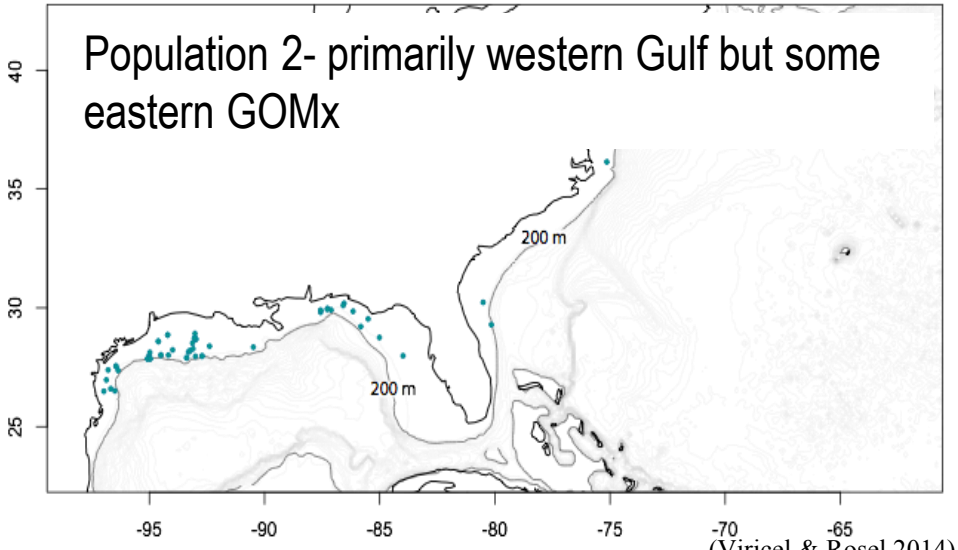
Viricel, A. and P. E. Rosel. 2014. Hierarchical population structure and habitat differences in a highly mobile marine species: the Atlantic spotted dolphin. Molecular Ecology 23:5018-5035.

Atlantic Spotted Dolphin- cryptic structure

- Strong evidence for two populations within GOMx
- Some overlap in north-central GOMx
- Known biogeographic break in the area
- Challenge to identify boundary to delimit 2 stocks







(Viricel & Rosel 2014)

Open water *Tursiops* in the Gulf of Mexico

Problem: 5 stocks delimited by inference of environmental characteristics Very broad geographic ranges

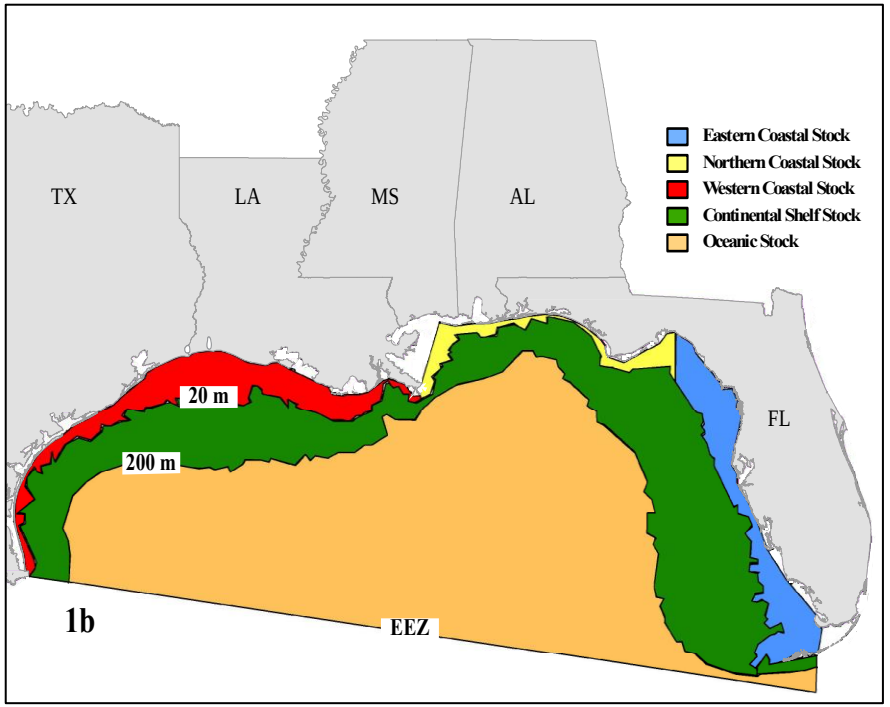
Goal: Understand stock structure for *Tursiops* in the GOMx

Method:

- Field sampling over 14 years n= 563
- Sequenced mitochondrial control region
- Genotyped 19 microsatellite markers
- Developed Single Nucleotide Polymorphism (SNP) markers (n=52) for *Tursiops*

Common bottlenose dolphin SEFSC MMPA Permit

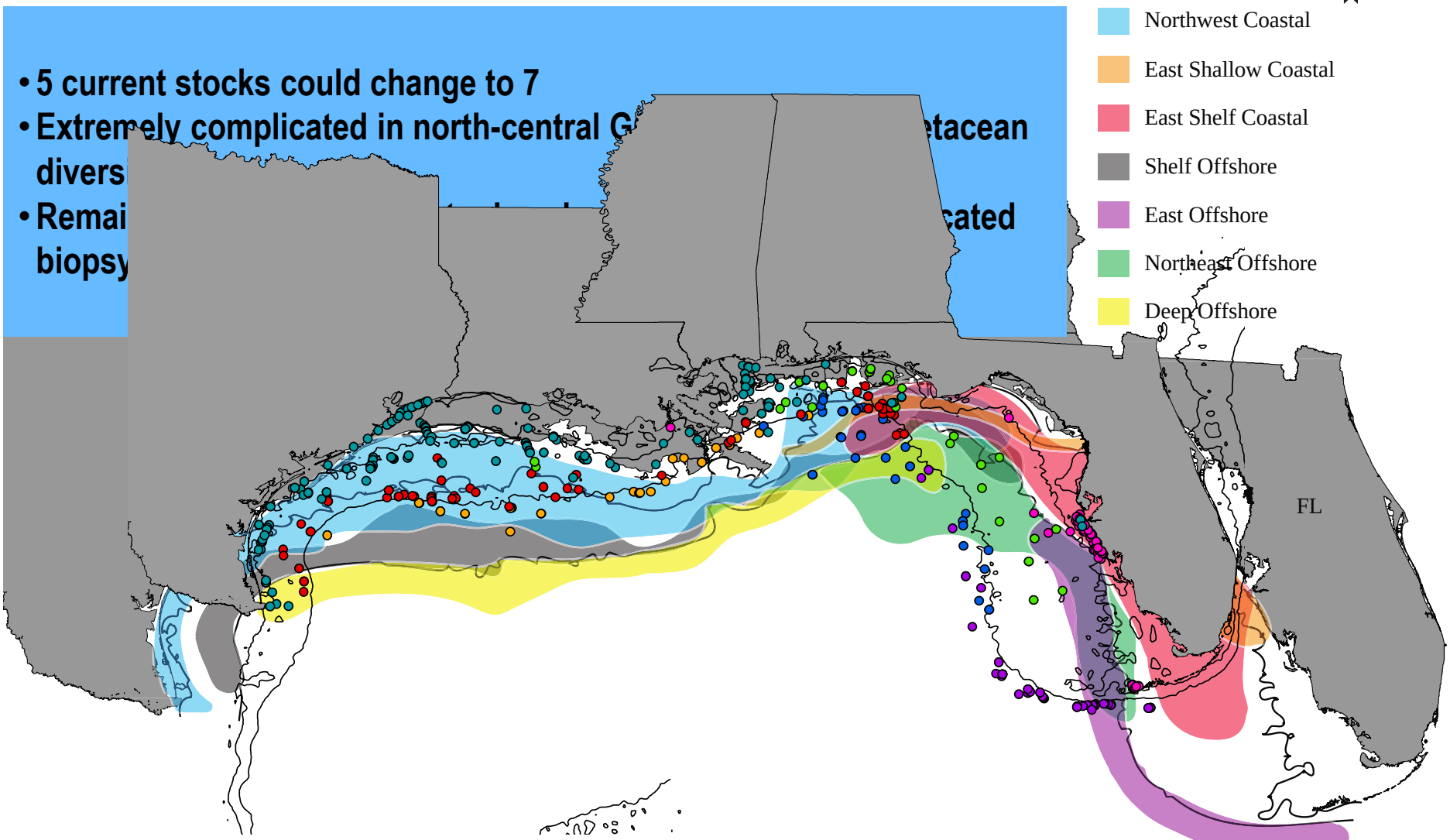
Current stock structure for common bottlenose dolphins in GOMx



Vollmer & Rosel in prep. Identifying common bottlenose dolphin populations in coastal and offshore waters of the U.S. Gulf of Mexico using multiple molecular markers.

Open water *Tursiops* in the Gulf of Mexico

- 5 current stocks could change to 7
- Extremely complicated in north-central G… …etacean divers…
- Remai… …cated biopsy…



200m and 2000m isobaths are shown

(Vollmer & Rosel in prep.)

Stock Structure -Additional Methodologies

- Complementary methods
- Bring stock structure to adequacy score of 3
  - Stable Isotopes – North Carolina estuarine stock
  - Telemetry – Atlantic coastal Tursiops stocks
  - Photo-ID – Biscayne Bay, North Carolina estuarine stocks
  - Contaminants – Biscayne Bay
  - Passive acoustic monitoring – oceanic stocks

Strengths

- Dedicated marine mammal genetics laboratory - allows for addressing stock questions and targeted marker development specific to our species
- Improved protection for stocks and identification of at risk stocks
- Management driven science
- Strong emphasis on data quality
- Extensive collaborations with other researchers

Challenges

- Many stocks
- Sampling – few dedicated biopsy surveys, particularly in oceanic waters
- Throughput
- Keeping current with 21st century technologies and analytical advancements
- Balancing typical planned projects with unexpected workloads of major events

Future Directions

- Incorporating next generation sequencing technologies
- Developing nuclear markers for improved species identification and stock assignment
- Improving understanding of stock structure for oceanic stocks and for bottlenose dolphin bay, sound and estuary stocks

Discussion Topics

- Is the work we are doing reflective of scientific best practices?
- Do you see a need, and if so an opportunity, for SEFSC to shift resources from an existing activity to deal with an unmet need?
- Discuss the major limitations/weaknesses of the marine mammal genetic studies and how they could be resolved

Pilot whale and oil rig and support vessels in northern Gulf of Mexico

SEFSC MMPA Permit